

WHAT IS CLAIMED:

1. A method comprising:
providing a radio frequency electrical signal at a fundamental frequency to a plasma drive electrode; and
providing a supplemental signal, controlled separately from the radio frequency electrical signal, at a frequency harmonic to the fundamental frequency and having a controlled phase relationship with the fundamental frequency, to the plasma drive electrode
2. The method as in claim 1, wherein the supplemental signal comprises a plurality of signals, each of the plurality of signals being at a frequency harmonic to the fundamental frequency and in phase with the fundamental frequency.
3. The method as in claim 2, wherein the plurality of signals are at frequencies selected from the group consisting of: first harmonic, second harmonic and third harmonic of the fundamental frequency.
4. The method as in claim 1, wherein a plasma produced by the plasma drive electrode in a plasma generator produces an etch rate which is more uniform than an etch rate produced by the radio frequency electrical signal without the supplemental signal.
5. The method as in claim 1, further comprising:
measuring parameters of the radio frequency electrical signal and the supplemental signal; and
controlling the radio frequency signal and the supplemental signal based on the measured parameters.
6. The method as in claim 5, further comprising:
determining a phase difference between a drive frequency generated within a plasma produced by the plasma drive electrode and the fundamental frequency; and
controlling the radio frequency signal and the supplemental signal to produce a time-independent phase difference.

7. The method as in claim 5, further comprising:
correlating the measured parameters with parameters of a plasma produced by the plasma drive electrode; and
controlling the radio frequency signal and the supplemental signal based on desired values for the parameters of the plasma.

8. The method as in claim 6, wherein the parameters of the plasma are selected from the group consisting of: etch rate, deposition rate, uniformity of the etch or deposition rate, selectivity of the etch of one material relative to the etch of another material, the uniformity of the selectivity, feature profile (or anisotropy), the uniformity of the feature profile, deposited film stress, and the uniformity of the deposited film stress.

9. A device comprising:
means for producing an electrical signal having a fundamental frequency;
means for producing a separately controlled supplemental electrical signal having a frequency which is a harmonic of the fundamental frequency and which is in phase with the electrical signal; and
a plasma drive electrode, driven by the electrical signal and the supplemental electrical signal.

10. A device comprising:
a signal generator which produces an electrical signal having a fundamental frequency;
a supplemental signal generator which produces a supplemental signal having a frequency which is a harmonic of the fundamental frequency and which is in phase with the electrical signal; and
a plasma drive electrode, driven by the electrical signal and the supplemental electrical signal.

11. The device as in claim 10, wherein
an oscillator controlled by an oscillator controller is included in the signal generator;

a harmonic generator is included in the supplemental signal generator and further comprises a phase shifter controlled by a phase controller to adjust the phase of the supplemental signal relative to the fundamental frequency electrical signal.

12. The device as in claim 11, further comprising:

a first circuit branch with a first match network having a frequency compatible with that of the fundamental frequency signal;

a second circuit branch with a second match network having a frequency compatible with that of the supplemental signal, through which the supplemental signal flows;

an amplifier circuit disposed in the second circuit branch to amplify the supplemental signal;

a coupler, at which power from the oscillator is sent into the second circuit branch for harmonic generation;

the phase shifter disposed in the second circuit branch for controlling the phase of the supplemental signal relative to the fundamental frequency electrical signal;

a combination node, disposed between respective ends of the first and second circuit branches and the plasma electrode at which the fundamental frequency signal and the supplemental signal are combined into one signal;

a voltage-current probe disposed between the combination node and the plasma electrode to measure the properties of the combined signal; and

a system monitor in electrical communication with at least one branch of the device to monitor the device.

13. The device, as in claim 10, further comprising:

a clock having a frequency that is an integral multiple of the fundamental frequency of the radio frequency electrical signal; and

a divider circuit to produce the fundamental frequency electrical signal and the supplemental signal from the signal provided by the clock;

14. The device, as in claim 13, further comprising:

a first circuit branch with a first match network having a frequency compatible with that of the fundamental frequency electrical signal;

a second circuit branch with a second match network having a frequency compatible with that of the supplemental signal;

a phase shifter controlled by a phase controller disposed in the second circuit branch to control the phase of the supplemental signal relative to the fundamental frequency electrical signal;

a first amplifier circuit to amplify the fundamental frequency electrical signal;

a second amplifier circuit to amplify the supplemental signal;

a combination node, disposed between respective ends of the first and second circuit branches and the plasma electrode at which the fundamental frequency signal and the supplemental signal are combined into one signal;

a voltage-current probe disposed between the combination node and the plasma electrode to measure the properties of the combined signal; and

a system monitor in electrical communication with at least one branch of the device to monitor the device.

15. The device as in claim 13, further comprising:

a first circuit branch with a first match network having a frequency compatible with that of the fundamental frequency signal;

a second circuit branch with a second match network having a frequency compatible with that of the supplemental signal;

a phase shifter controlled by a phase controller disposed in the first circuit branch to control the phase of the supplemental signal relative to the fundamental frequency electrical signal;

a first amplifier circuit to amplify the fundamental frequency electrical signal;

a second amplifier circuit to amplify the supplemental signal;

a combination node, disposed between respective ends of the first and second circuit branches and the plasma electrode at which the fundamental frequency signal and the supplemental signal are combined into one signal;

a voltage-current probe disposed between the combination node and the plasma electrode to measure the properties of the combined signal; and

a system monitor in electrical communication with at least one branch of the device to monitor the device.

16. The device, as in claim 10, further comprising:
a clock having a frequency that is an integral multiple of the fundamental frequency; and
a plurality of divider circuits to produce the fundamental frequency electrical signal and the supplemental signal from the signal provided by the clock,
the supplemental signal including a plurality of frequencies produced by the divider circuits.

17. The device, as in claim 16, further comprising:
a first circuit branch with a first match network having a frequency compatible with that of the fundamental frequency signal, through which the fundamental frequency signal flows;
a plurality of lower frequency circuit branches, each having a respective match network, each respective match network having a frequency corresponding to that of one of the plurality of frequencies harmonic to the fundamental frequency, through which a signal having one of the plurality of frequencies flows;
phase shifters controlled by phase controllers disposed in two of the lower frequency circuit branches to control the phase of the plurality of lower frequency signals relative to the fundamental frequency electrical signal;
a combination node, disposed between respective ends of the first and second circuit branches and the plasma electrode at which the fundamental frequency signal and the supplemental signal are combined into one signal;
a voltage-current probe disposed between the combination node and the plasma electrode to measure the properties of the combined signal; and
a system monitor in electrical communication with at least one branch of the device to monitor the device.